BRÜEL & KJÆR
Nærum - Denmark

Service Instructions
Electronic Voltmeter

2409
2416

Consisting of:

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All the tolerances and the adjustment procedure are the same for type 2409 as well as for type 2416, which has the same electrical specifications but is equipped with a front plate for 19" rack mounting.

Removal of the Metal Case.

After removing the nuts at the back of the instrument, it is possible to slide the chassis and the front panel out of the case.

Trouble Shooting.

If the reason for a fault is not an obvious one such as a dead tube, broken down resistor, blown or disconnected fuse etc., then first test the voltages of all the tubes and compare them with the voltages shown in the circuit diagram in order to localize the defect. Should this method of finding the fault prove unsuccessful, then check the instrument by adopting the method described in the adjustment procedure. When the trouble has been found and remedied, the voltages and adjustments which are influenced by the remedy must be checked.

The tolerances stated in the instructions can only be used as a guide for adjustment and control, but any deviations must not be corrected without being sure that the tolerances of the instruments used for making the adjustment are so small as to have no influence on the measurements.

The instructions in this Manual are given purely as a guide to the service of equipment with minor faults. Some faults, as f.i. small deviations in tolerances require for their correction special control equipment and extensive experience, and in these cases it is necessary to send the instrument to the factory.

Note.

The three anticlockwise positions of the METER SWITCH give the smaller damping of the indicating meter designated either as LOW DAMPING or VU DAMPING.

The three clockwise positions give the higher damping of the indicating meter designated either as HIGH DAMPING or SLOW. In the following text the terms HIGH or LOW are used to express these METER SWITCH positions.

Instruments necessary for service and repair.

Multimeter (50 μA)

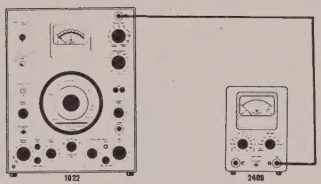
Frequency Analyzer Type 2107.

Beat Frequency Oscillator Type 1022

(Beat Frequency Oscillator Type 1013)

Meter Circuit

valid from serial no. 144497



1.1. Mechanical Zero-point

METER RANGE: "Off"

Adjust for 0 with no power on.

1.2. Electrical Zero-point

METER RANGE: "10 V"
METER SWITCH: "RMS low"

Check that the pointer is still at 0. Tolerance: 1/2 pointer "width".

1.3. Dynamic Characteristics

METER SWITCH: "Average low"
METER RANGE: "Off"

Frequency: 1000 c/s. Adjust the input voltage for a 9 V deflection on type 2409. The input signal is switched off and on, and the overswing is checked.

Deflection on type 2409: 9.05-9.20 V.

If necessary change value of R 49.

1.4. Sensitivity

METER SWITCH: "RMS low"
METER RANGE: "Off"

Frequency: 1000 c/s. Adjust the input voltage for a 10 V deflection on type 2409. The input voltage should be within 8-11 V.

Possible reason for fault: defective diodes Q 4 - Q 7.

If cold cathode tube V 8 is dark change both V 8 and V 4

Whenever V 2 or V 4 is replaced P 4 should be adjusted to V_k (pin 2, V 4) is 110 V d.c.

1.5. Check of Meter Switch

a. METER SWITCH: "RMS low"
METER RANGE: "Off"

Frequency: 1000 c/s. Adjust the input voltage for a 16 dB deflection on type 2409.

b. METER SWITCH to "Average low"

Deflection on type 2409: 14.9 - 15.3 dB.
If necessary adjust P 5.

c. METER SWITCH to "Peak low"

Deflection on type 2409: 18.5 - 19.5 dB.

If necessary adjust P 5 and repeat item b.

Also check a-b-c at 20 c/s in position "high".

Amplifier

2409.2

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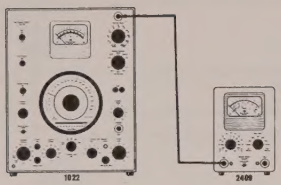
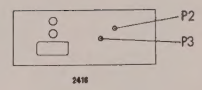
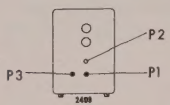






Rear wiev

2.1. Sensitivity

METER RANGE: "10 mV"
METER SWITCH: "RMS low"

Input signal: 10 mV 1000 c/s.

Deflection on type 2409: 10 V.

If necessary adjust P 1. (Sen.Adj.)

If impossible to adjust to full scale deflection, check voltage on the OUTPUT socket: 8-11 V.

Possible reasons for fault: defective tubes V1 - V2 - V 4

Whenever V 2 or V 4 is replaced P 4 should be adjusted to V_k (pin 2, V 4) is 110 V d.c.

2.2. Reference

a. METER RANGE: "10 V"
METER SWITCH: "RMS low"

Input signal: 8 V 1000 c/s.
Deflection on type 2409 should be 8 V, if not check item 2.1.

b. METER RANGE to "Ref"

Deflection on type 2409: 8 V (red line). If necessary adjust P 3.

2.3. Frequency Response 20-1000 c/s.

METER RANGE: "10 mV"
METER SWITCH: "RMS high"

Frequency: 1000 c/s. Adjust the input voltage for a 25 V deflection on type 2409 (on 0 - 30 V scale).

Vary the frequency from 20-1000 c/s.
Deflection on type 2409: 24.5-25.5 V (on 0 - 30 V scale).
If necessary adjust P 6

2.4. Frequency Response 1000 - 200.000 c/s

a. METER RANGE: 10 mV.
METER SWITCH: "RMS low"

This can only be checked by means of a high frequency oscillator type 1013 connected to the INPUT socket.
Frequency: 1000 c/s. Adjust the input voltage for a 9.8 V deflection on type 2409.
Change frequency to 200ooo c/s.
Deflection on type 2409: 9.6-10 V.
If necessary adjust C.31.

b. METER RANGE to 100 V.

Frequency: 1000 c/s. Adjust the input voltage for a 9.8 V deflection on type 2409.
Change frequency to 50.000 c/s.
Deflection on type 2409: 9.6-10 V.
If necessary adjust C 32.

c. METER RANGE to 1 V.

Frequency: 1000 c/s. Adjust the input voltage for a 9.8 V deflection on type 2409.
Change frequency to 50.000 c/s.
Deflection on type 2409: 9.6-10 V.
If necessary adjust C 33.

Change frequency to 200.000 c/s.
Deflection on type 2409: 9.6-10 V.
If necessary adjust the metal wire across R 41 and check item b and c again.

2.5. Output Impedance

METER RANGE: "10 V"
METER SWITCH: "Peak low"

Frequency: 1000 c/s. Adjust the input voltage for a 18 dB deflection on type 2409. Load the OUTPUT socket with a resistor of 1000 Ω.

Deflection on type 2409: 17.6 - 18 dB
If necessary adjust P 4.
After adjustment check that the d.c. voltages on V_k, V 4 is within 100-120 V.

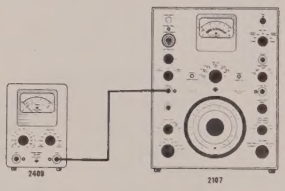
2.6. Input Impedance

METER RANGE: "300 mV"
METER SWITCH: "RMS low"

Frequency: 50 c/s. Adjust the input voltage for a 20 dB deflection on type 2409.

Insert a screened resistor of 10 MΩ in series with the generator.

Deflection on type 2409: 13-15 dB.



2.7. Noise - Hum

METER RANGE: "10 mV"
METER SWITCH: "RMS high"

The apparatus should be inserted into the cabinet and connected to ground.

a. Open input: adjust potentiometer P 2 for min. voltage on the OUTPUT socket. Tolerance: max. 100 mV.

Possible reasons for faults: defective tube V 1.
no electrical contact between the different parts of the instrument housing.

b. Short-circuited input: Tolerance max. 20 mV

Check all positions of METER RANGE switch.

2.8. Distortion

METER RANGE: "300 mV"
METER SWITCH: "RMS low"

Distortion down to around 0.5% can be measured with type 2107. Lower distortion measurement requires the use of a filter type 1607 connected between type 2409 and type 2107 for rejection of the fundamental frequency and a filter connected between type 1022 and type 2409 to ensure that the distortion of the input signal is lower than 0.01%. If these filters are available check limits:

Input signal:	300 mV	1000 c/s
Distortion max.	0.18% at	2000 c/s
" "	0.05% at	3000 c/s

2.9. Overdrive

a. Turn the METER RANGE slowly through all positions.

Open input: deflection on type 2409 must not exceed 1/3 scale deflection.

Possible reasons for fault: defective C 2
Leakage current in C2 max. 0.2 μA at 20V d.c.

Position of Components

2409.3

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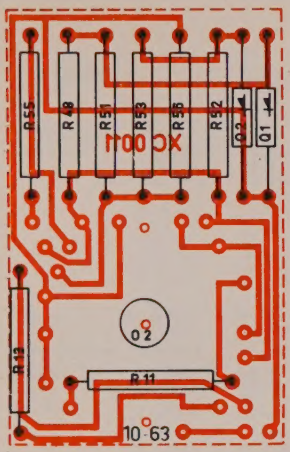

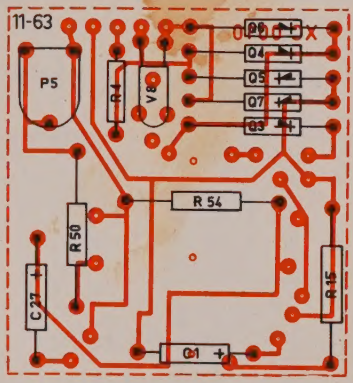

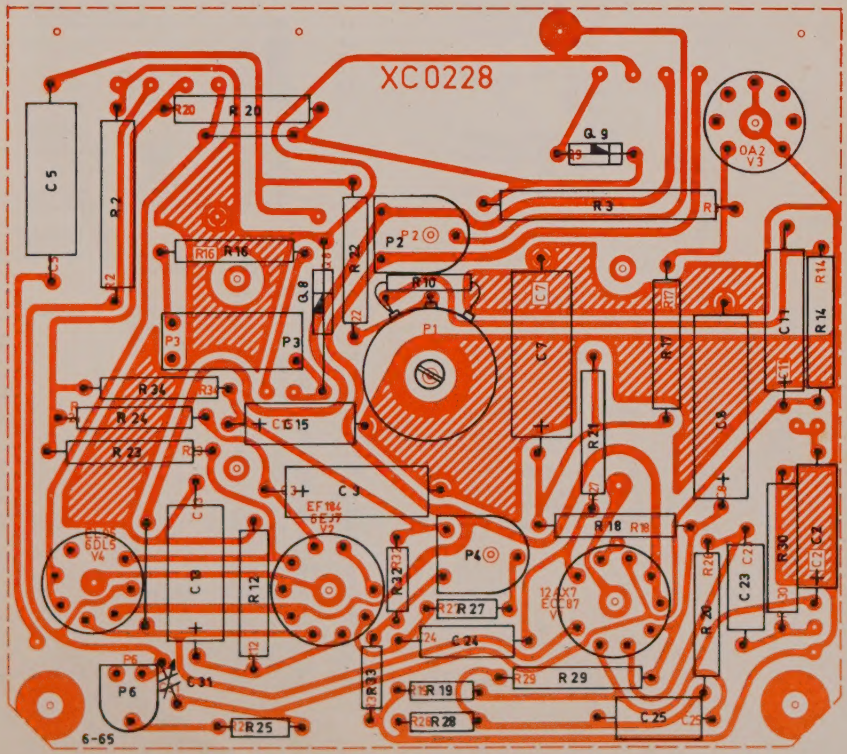

Parts - List

2409.4

valid from serial no. 186456

COMPONENT TYPE		STOCK REFERENCE	CIRCUIT DIAGRAM REF.
CAPACITORS:			
Electrolytic	4 µF/250 V	CE 2034	C 1
"	40 µF/150 V	CE 2038	C 7.8
" bipolar	25 µF/ 35 V	CE 0412	C 5
"	2 x 100 µF/350 V	CE 2989	C 9.10
"	640 µF/ 16 V	CE 0209	C 13.14
"	16 µF/ 63 V	CE 0504	C 2.27
"	50 µF/ 50 V	CE 0503	C 6
"	50 µF/ 25 V	CE 8965	C 15
"	200 µF/ 6 V	CE 8944	C 11.12
"	8 µF/320 V	CE 0802	C 3
Ceramic	4.7 pF/400 V	CK 0470	C 29
"	27 pF/400 V	CK 1270	C 30
Metallized paper	16 µF/160 V	CP 0005	C 28
Polyester	1 µF/250 V	CS 0025	C 26
"	220 nF/250 V	CS 0017	C 25
"	470 nF/250 V	CS 0021	C 24
"	47 nF/400 V	CS 0109	C 23
Polystyrene	180 pF/200 V	CT 0233	C 21
"	21.6 nF/200 V	CT 3129	C 22
Trimmer	0.7 - 3 pF/400 V	CV 0113	C 31.32
"	3 - 30 pF/400 V	CV 7864	C 33
POTENTIOMETERS:			
Pot.m. wire-wound	500 Ω/2 W	PQ 1501	P 1
Pot.m. carbon	1 kΩ lin.	PG 2100	P 2
" "	5 kΩ lin.	PG 2500	P 5
" wire-wound	5 kΩ lin.	PG 2504	P 3
" carbon	100 kΩ lin.	PG 4102	P 4
" "	1MΩ lin.	PG 5102	P 6
RECTIFIERS:			
Germanium diode	150 V	QV 0020	Q 4-7
" "	OA85	QV 0085	Q 2.3
" "	OA79	QV 0078	Q 1
Zener diode	6.8 V ± 10%	QV 1106	Q 8
Silicon diode	1200 V/o.15A	QV 0025	Q 9
RESISTORS:			
Wire-wound	2 W 7 kΩ	RO 0803	R 2
"	6 W 25 kΩ	RO 0900	R 3
"	1/3 W	RK o.8 MΩ	R 25
Carbon film	1/3 W ± 10%	RK 100 Ω	R 1
"	1/2 W ± 5%	RK 125 Ω	R 10
"	" 10%	RK 160 Ω	R 11
"	" "	RK 200 Ω	R 13
"	" "	RK 1 kΩ	R 14
"	" "	RK 3.15 kΩ	R 12
"	" "	RK 5 kΩ	R 20
"	" "	RK 6.3 kΩ	R 50
"	" "	RK 20 kΩ	R 17
"	" "	RK 50 kΩ	R 18.21
"	1 W "	RK 80 kΩ	R 23
"	1/2 W "	RK 160 kΩ	R 24
"	" "	RK 500 kΩ	R 34
"	" "	RK 2 MΩ	R 26
"	" "	RK 25 MΩ	R 29.30
"	1 W "	RK 100 kΩ	R 31
"	1/2 W ± 5%	RK 7 kΩ	R 15
"	" "	RK 11 kΩ	R 16
"	" "	RK 20 kΩ→∞	R 49
"	" "	RK 100 kΩ	R 22
"	1/3 W ± 10%	RK 50 Ω	R 4
"	" "	RK 10 kΩ	R 32
"	" "	RK 13.2 kΩ	R 33
"	" "	RK 50 kΩ	R 19
"	" "	RK 315 kΩ	R 27
"	" "	RK 500 kΩ	R 25
"	" "	RK 5 MΩ	R 28

COMPONENT TYPE		STOCK REFERENCE	CIRCUIT DIAGRAM REF.
PRECISION RESISTORS:			
Carbon film	1/2 W ± o.5%	RK 462.2 Ω	R 47
"	" "	RK 1 kΩ	R 46
"	" "	RK 1.01 kΩ	R 43
"	" "	RK 3.15 kΩ	R 45
"	" "	RK 10 kΩ	R 44
"	" "	RK 101 kΩ	R 42
"	" ± 1%	RK 2.66 kΩ	R 48
"	" "	RK 8.9 kΩ	R 51
"	" "	RK 17.6 kΩ	R 52
"	" "	RK 19.7 kΩ	R 53
"	" "	RK 23.7 kΩ	R 54
"	" "	RK 34.3 kΩ	R 55
"	" "	RK 49 kΩ	R 56
"	1 W ± o.5% 10 MΩ	RH 0100	R 41
TUBES:			
Twintriode	ECC83/12AX7	VA 0012	V 1
Pentode	EL95/6DL5	VA 0026	V 4
Pentode	EF184/6EJ7	VA 0079	V 2
Stabilizer	OA2	VA 0037	V 3
Cold cathode tube	90 V	VA 0072	V 8
Fuse	1 Amp.	VF 0008	V 7
Pilot lamp	6.3 V/o.25 A	VS 1273	V 6
PRINTED CIRCUIT:			
Printed circuit		XC 0228	
"		XC 0010	
"		XC 0011	
Printed circuit	XC 0228 with comp.	2409 bl. 805	
"	XC 0010 "	2409 bl. 808	
"	XC 0011 "	2409 bl. 809	
MISCELLANEOUS:			
Power cord. EUR.		AN 0005	
Power cord. USA		AN 0006	
Rubber foot (only for 2409)		DF 7007	
Spring for tube		DL 0025	
Moving coil instrument 200 µA		IN 2409	I
Coaxial jack		JJ 0115	
Coaxial plug		JP 0018	
Jack for grounding		JT 6204	
Socket for V 1, V 2		JV 9012	
Socket for V 3, V 4		JV 7505	
Cabinet (only for 2409)		KQ 2409	
Front plate (only for 2416)		FA 2416	
Attenuator switch (only for 2409)		OR 2409	O 1
Attenuator switch (only for 2416)		OR 2416	O 1
Meter switch (only for 2409)		OS 2409	O 2
Meter switch (only for 2416)		OS 2416	O 2
Power voltage selector		OA 0012	O 3
Bakelite knob (only for 2409)		SN 0807	
Bakelite knob (only for 2416)		SN 0814	
Power transformer		TN 8926	T

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Circuit Diagram

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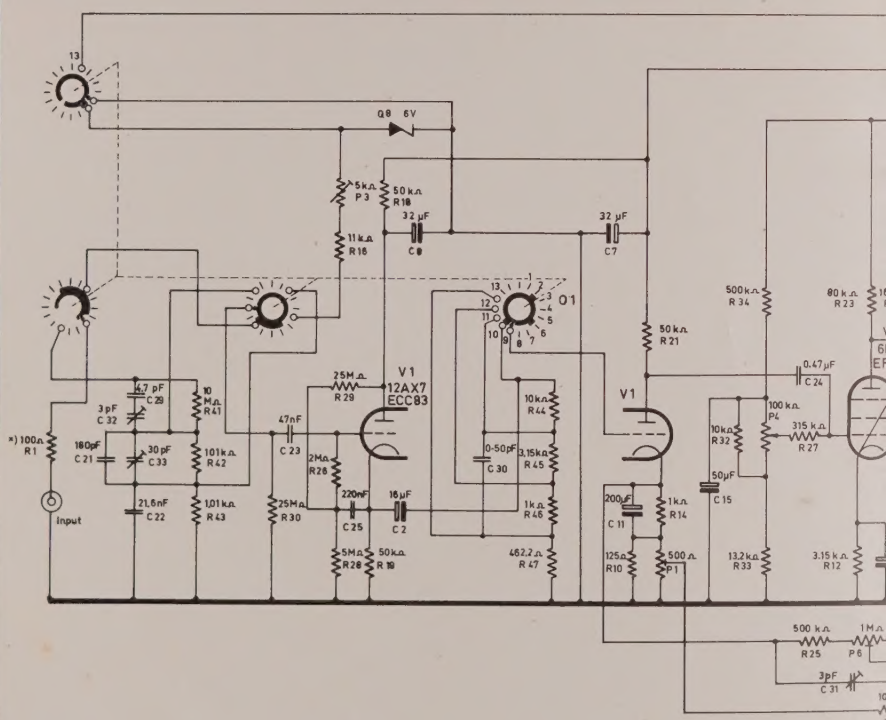
2409.5



For 2409 only

01: Meter Range

1:	Off	
2:	0.01 V	
3:	0.03	»
4:	0.1	»
5:	0.3	»
6:	1	»
7:	3	»
8:	10	»
9:	30	»
10:	100	»
11:	300	»
12:	1000	»
13:	Ref.	

*) Only in type 2409

For 2416 only

01: Meter Range

2:	0.01 V	
3:	0.03	»
4:	0.1	»
5:	0.3	»
6:	1	»
7:	3	»
8:	10	»
9:	30	»
10:	100	»
11:	300	»
12:	1000	»
13:	Ref.	

02: Meter Switch

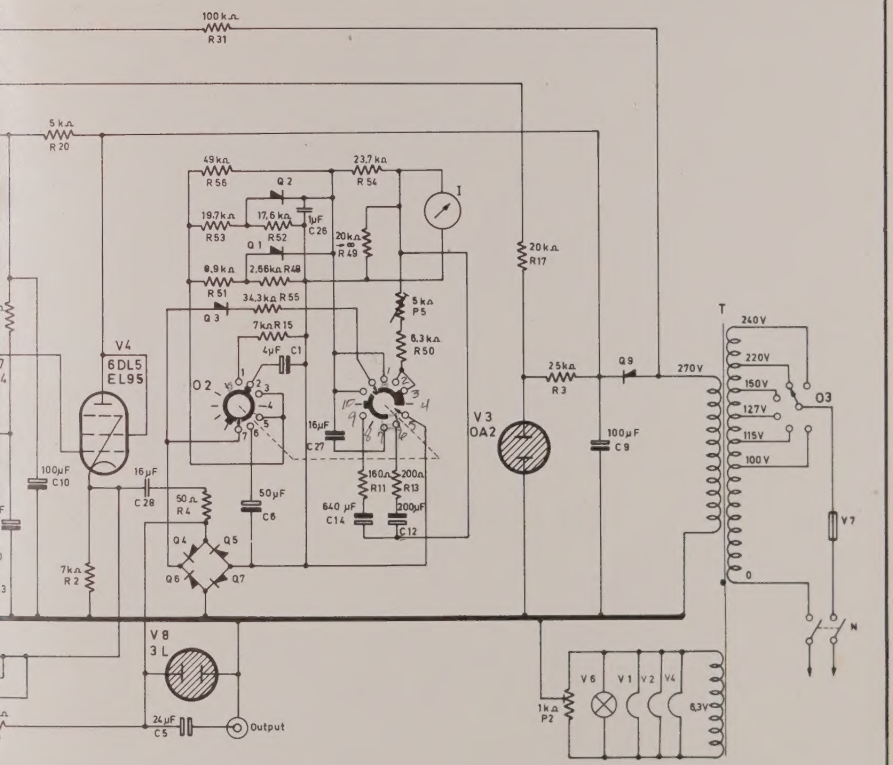
1:	Average	Low	Damping
2:	Peak	»	»
3:	RMS	»	»
4:	Off	»	»
5:	RMS	High	Damping
6:	Peak	»	»
7:	Average	»	»

Switch 01 is shown in position 0.01 V

Switch 02 is shown in position Peak Low Damping.

On type 2416 the front plate is insulated from the chassis.

10-5-65



V1

f a 90-130 V g k 13-21 V fc

AX7
CC83

V2

f f k a 90-115 V 7-10 V g1 g2 125-180 V 9-12 V k g3

6EJ7
EF184

V3

k i.c. a 135-165 V k i.c. a k

OA2

V4

f f a 280-330 V 100-120 V kg3 g2 g1 g1

6DL5
EL95

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Electronic Voltmeter
Type 2409/2416